JUNE
1969
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Live Steam®

THE MONTHLY MAGAZINE FOR ALL LIVE STEAMERS AND LARGE-SCALE MODEL RAILROADERS

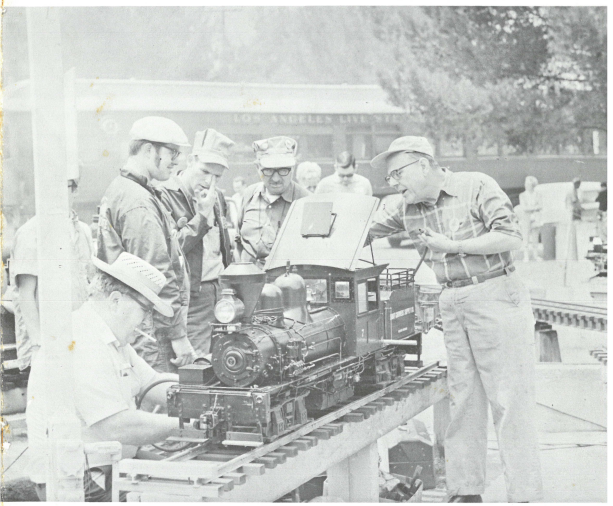

Photo Reports of Spring Meets

Walschaerts Valve Gear

Live Steam
magazine

JUNE 1969 VOL. 3 NO. 6

CONTENTS

2 *Candid Shots at the Spring Meets*

4 *The Case For 3/4" Scale*

5 *So You Want To Build A Live Steam Locomotive*

9 *building the RARITAN*

10 *HEAT TREATMENT for the apprentice*

12 *Live Steam News*

13 *Live Steam News Scheduled Meets*

14 *mail stop*

COVER PHOTO

Francis Moseley (right) explains to his audience his plans for this beautiful 1½" Shay which was built by the late Gordon Corwin. See additional report on the LALS Spring Meet on page 12. Photo by Bruce Ward, processing by Douglas Alkire.

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A pronounced cold front chilled the air in Clarendon Hills just as the LIVE STEAM staff arrived for the Northern Illinois Live Steamers' Spring Meet at Dave Boyd's home . . . and the resulting rain was considered to be the contribution from Northern Michigan! In spite of inclement weather, a goodly turnout of Live Steamers from all around the Chicago area as well as Wisconsin, Indiana, Ohio, Michigan and California were on hand. Dave Boyd (1) began the run with a few turns around the track on his 1"" scale Pacific; Larry Edwards ran almost continuously, rain or not (see photo on page 4 of this issue); Nick Schaub with his incompleted 0–6–0 (2) and Bud Novy on Russ Dechu's 2–6–0 double-headed to handle passenger traffic on wet rail. Much interest centered in Dave's garage where (3) Carl Ulrich (1 to r) discussed his air-operated bell with Seymour Johnson as Bill Zimmer and Larry Edwards looked on. Main area of activity, though, was in Dave's basement (4) where his 1½"" Big Boy chassis was on display. Such a basement we should all have!!! Besides a fully equipped workshop where he has built his 1"" 4–6–2 and his 1½"" 4–6–4, facilities include a complete photo processing dark room, extensive testing equipment (where Dave can determine factual data on all sorts of materials and mechanical devices) and an operating 8,000 word, 128 command digital computer built by local high school students under Dave's tutorage. Russian scientists visited the basement several years ago and were very impressed with the activity being conducted there. Needless to say, many of the Live Steamers who were in attendance at the meet were equally impressed!

Candid Shots

Possibly the last meet of the Pennsylvania Live Steamers on the track that they have used for nearly twenty years was held over the Memorial Day weekend. The beautifully landscaped and impeccably maintained grounds furnished by member Kenneth Souser for the Club's 2½"", 3½"" and 4½"" track must be put to other use and a committee is searching for another location. A handful of Live Steamers with a half-dozen locomotives spent a very enjoyable Saturday at the track with Stanley Robinson (5) with his 1"" 4–4–0 representing the New Jersey Live Steamers on the tracks, although several others from the NJLS were in attendance. Workhorse for the meet was a finely-crafted RDG 4–6–0 by H. S. Hoopes (6) which performed admirably the whole day. (That's Frank Moore, Jr., frequent contributor to LIVE STEAM in the background.) LIVE STEAM's Editor, Bill Fitt, (7) with the engine's builder made several trips around the track with the 1"" Pacific as well as Carl Dougherty's "Tom Thumb" which is following in the background. Author William Morewood turned in a good performance with his "RARITAN" (8) which would not take a back seat for any engine at the track. With no apparent effort it towed its builder and your editor around the track . . . with the editor contributing the largest share of the 3500 load on the dining car! The weatherman was most cooperative for the day, making it pleasant to meet old friends and make new ones. Much of the conversation centered around discussion of a new location for the track and you can be certain that, once a new site is obtained, there will be lots of activity in the Philadelphia area.

PHOTO 4 BY DAVE BOYD
PHOTO 7 BY PAUL FITT
OTHERS BY WM. C. FITT

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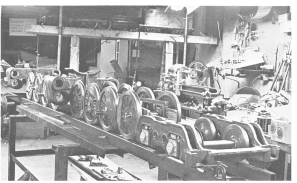

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at the Spring Meets

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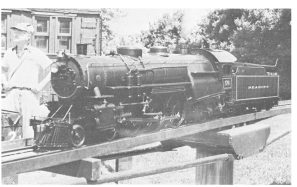

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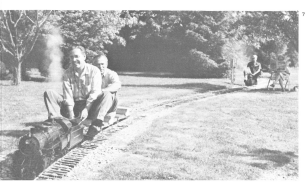

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8

The Case For 3/4" Scale

by Robert W. Maynard

PHOTOS BY WM. C. FITT

The idea that a ¾" scale track must be elevated is deeply ingrained on the minds of most Live Steamers. The up-rooting of such a fixed idea is difficult, if not almost impossible, but in an attempt to do so I shall point out the advantages of ground level operation in 3½" gauge.

Assuming that you have already acquired a ¾" scale locomotive, either by building or buying, the next logical step is the construction of a railroad in your own yard. First advantage of a ground level track is cost. The expense of an elevated assembly is considerably more due to additional material used and the maintenance of such a structure is more costly and physically more difficult to keep in proper repair. The second is safety – a most important point in the long life of a locomotive. The third is the ease of following the contours of the land and the only trestle used is the length necessary for maintaining the grade. The fourth is the sense of security the passengers receive from the closeness of the ground.

The greatest disadvantages of ground level track are firing up on one's hands and knees and the loading of passengers. A short section of trestle, a track along a wall, a pit, or perhaps the use of the terrain to take advantage of a hill can be built into the layout and will provide a good answer. The height of this section should be between 18" and 24", depending upon one's personal preference.

Engines must be modified for low level running. It is necessary to be able to reach the throttle from a sitting position on the riding car. The reverse gear and the feed water pump are not absolutely essential but it is a definite advantage to have these controls easily accessible. A short tank engine presents no problem as the absence of a tender makes this transition from trestle to ground quite easy. A locomotive with a tender, and particularly a large one, makes the extension of controls a bit more difficult, but not impossible. A long shovel will usually take care of firing problems and the "big" engines will operate a mile or more before fuel need be added. Even on the longest tracks, engines seldom run a mile without stopping... the fellow ahead of you who always stops will see to that!

To increase stability on the narrow rails, the addition of a larger gauge (by using a third rail) should overcome many objections. The stability of the larger gauges cannot be denied and one may as well take advantage of this mechanical fact, for inexperienced riders will cause derailments. I would suggest 1½" as this is the most stable and gives best results.

No doubt the question has already risen: "why ¾" scale if you are going to 1½" scale for cars?"

Even a very small 1½" engine, one that corresponds with the conventional idea of an engine, will tip the scales at almost 200 lbs., and this is more than one man can handle. The small American and 4–2–4T types in 1½" will not perform as well as a good running ¾" scale in a 4–4–2 or 4–6–2. This is from personal observation and some practical experience.

The advantages of the smaller scale cannot be denied. Cost, ease of building and portability are important factors in engine building. True, there are also advantages inherent in larger scales and one must decide for himself which is best for his own use. My intention is to help the newcomer in his choice, perhaps giving him some points the total exponents of the larger scales do not consider.

Bill Morewood's ¾" RARITAN moves right along on the 3½" gauge ground level track at Paoli with Paul Fitt as a passenger.

Larry Edwards finds comfort on two flat cars behind his ¾" Atlantic on Dave Boyd's 3½" ground level track near Chicago.

Bill Morewood heads for the car after a pleasant day of running with the tender (and a tool box) in his left hand and his RARITAN in the right.

PART NINE

VALVE GEAR

SO YOU WANT TO BUILD A LIVE STEAM LOCOMOTIVE

by Joseph F. Nelson

CHAPTER 10

THE WALSCHAERTS VALVE MOTION

While the so-called link motions, such as the Stephenson, Gooch, and Allen, derive their movement from two eccentrics, and Hackworth from one eccentric and a fixed reversing link, or one eccentric and a swinging arm controlled by the reverse lever, the Walschaerts motion (in most cases) is driven from one rotating and one reciprocating point.

Egide Walschaerts' first motion was patented in 1844, and was not much of a success since it was a variation of the hook motion. However, it did introduce the lap and lead lever.

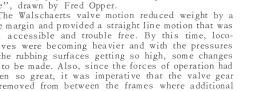
Walschaerts' second motion was his first practical valve gear, and, in principle, was fundamentally the same as the modern Walschaerts valve gear except that it was designed for inside cylinders and was mounted between the frames and was driven by eccentrics instead of return cranks. The greatest difference was that the link was mounted forward with the concave face to the rear. This placed the radius rod, union link, and lap and lead lever aft of the link. This arrangement was used by A. J. Stevens of the Central Pacific for his 4–10–0 "El Gobernador." This was Stevens' first motion. His second motion, also the Walschaerts principle, was used on many Southern Pacific (Central Pacific) locomotives, most of which disappeared by 1900.

Walschaerts' third motion came out in 1848 and is the modern Walschaerts valve motion. A German, Edmund Heusinger von Waldegg, pattented an identical motion in 1849 which was called the Heusinger, or Waldegg, by many of the early writers. However, there is no question as to Walschaerts being the original inventor.

In spite of its success on the European continent, the Walschaerts valve gear made little headway in either England or the United States. As previously mentioned, William Mason applied it to his Mason-Farlie bogie engines in the '70's and '80's with phenomenal success. However, he never followed it up on his Americans, probably for esthetic reasons, since in that period, an outside valve gear was not considered an artistic refinement.

The swing to the Walschaerts valve gear came in 1904 when the Baltimore & Ohio Railroad brought out its first Mallet (No. 2400). This was the first Mallet (compound) operated in the United States and it was equipped with a Walschaerts valve gear. It was designed by J. E. Muhlfield and was known affectionately as "Old Maud" from a funny paper character of that period "Maud the Mule", drawn by Fred Opper.

The Walschaerts valve motion reduced weight by a wide margin and provided a straight line motion that was both accessible and trouble free. By this time, locomotives were becoming heavier and with the pressures on the rubbing surfaces getting so high, some changes had to be made. Also, since the forces of operation had gotten so great, it was imperative that the valve gear be removed from between the frames where additional



SLIDE VALVE - OUTSIDE STEAM

PISTON VALVE - INSIDE STEAM

WALSCHAERTS VALVE MOTION

bracing was required. Stephenson link motion advocates had always touted the advantages of the variable lead feature of that gear. However, as previously mentioned, the variable lead feature has been built into some Walschaerts gears. This, however, added more parts to a mechanism in which simplicity and a minimum of maintenance was a virtue.

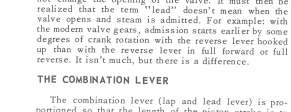
Many valve motions have used the Walschaerts principle as a basis of their design, but it is to be noted that in order to gain a minute advantage in steam distribu-

tion, a great sacrifice in simplicity resulted which increased costs. For example: Poppet valves give practically perfect steam distribution which results in superior locomotive performance. Superior performance, however, has to give way to the disadvantage of more locomotive failures and exhorbitant maintenance costs. The Pennsy T–1 (4–4–4–4) was designed with poppet valves, but due to high maintenance costs, the engineering department was considering the conversion of all of them to Walschaerts and piston valves. One of them, the 5547 had her poppets replaced with conventional Walschaerts valve gear and piston valves. It is safe to say that if time hadn't run out on steam with the advent of the diesels, all the T–1's would have been converted to piston valve in the interest of low maintenance costs and trouble-free operation. Where the maintenance department was concerned, simplicity with low operating costs took precedence over technical excellence and high costs every time.

The Walschaerts valve motion is a radial valve gear, that is, when the piston is on either front or back center, a set amount of admission valve opening is in effect (lead). Any movement of the reverser lever from full forward to full reverse, with the engine at rest, does not change the opening of the valve. It must then be realized that the term "lead" doesn't mean when the valve opens and steam is admitted. For example: with the modern valve gears, admission starts early by some degrees of crank rotation with the reverse lever hooked up than with the reverse lever in full forward or full reverse. It isn't much, but there is a difference.

THE COMBINATION LEVER

The combination lever (lap and lead lever) is proportioned so that the length of the piston stroke is to 2 (lap + lead) as the distance from the radius rod pin to



LAP AND LEAD LEVER

the union link pin is to the distance from the radius rod pin to the valve stem crosshead pin. This applies to both inside and outside steam.

RADIUS ROD

The radius rod is just what the name implies. Its length, center to center, is the distance from the lap and lead lever pin (with piston and valve centered) to the expansion link block pin at the link trunnion. Pivoted on the lap and lead lever, the other end of the radius rod will swing in an arc equal to the curvature of the link.

UNION LINK

The location of the union link, whether it is on the wrist pin or the bottom of the crosshead, determines the length of the lap and lead lever. Where the Live Steam builder is modeling a particular prototype, the union link should be located as per prototype. However, when the builder is going "Free Lance", he should locate the union link at or below the bottom of the crosshead, since the longer the lap and lead lever, the better. This is because the longer distance between the radius rod pin and the valve stem crosshead pin minimizes error caused by wear. This means that where there is a choice, the lower location of the union link is preferable. It must be remembered that when the union link moves back and forth with the crosshead, the lap and lead lever pin must swing equally to both sides of its center line of travel, with the amount of arc depending upon the swing of the lap and lead lever.

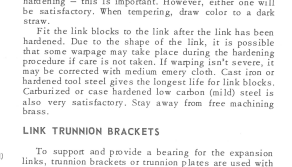
EXPANSION LINK

The radius of the slot is determined by the length of the radius rod. The expansion link should be made from mild steel and then case hardened, or better yet, tool steel. Starret or Simonds annealed flat ground tool steel, when properly hardened and tempered, will outlast the engine. Make certain whether it is oil hardening or water hardening – this is important. However, either one will be satisfactory. When tempering, draw color to a dark straw.

Fit the link blocks to the link after the link has been hardened. Due to the shape of the link, it is possible that some warpage may take place during the hardening procedure if care is not taken. If warping isn't severe, it may be corrected with medium emery cloth. Cast iron or hardened tool steel gives the longest life for link blocks. Carburized or case hardened low carbon (mild) steel is also very satisfactory. Stay away from free machining brass.

LINK TRUNNION BRACKETS

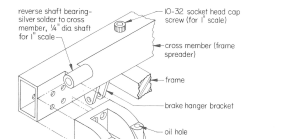
To support and provide a bearing for the expansion links, trunnion brackets or trunnion plates are used with the trunnion plate being the most popular. Compared with the trunnion brackets, trunnion plates are relatively


2 Rrt, 2 L H reqd, left side shown based on 1" scale
alignment shaft
bushing (ref) shaft (ref)
snug fit on link
alignment bushing
drill thru and ream before milling
drill thru #44, three places
top 4-40 S places, use socket head cap screws
saw off bracket bridge
dress up bracket
redrill outboard bracket end link #52
install trunnions, silver solder
EXPANSION LINK (PRR) WITH TRUNNION BRACKET IN PLACE
TRUNNION BRACKET

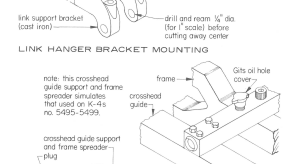
easy to fabricate. In any event, if a procedure isn't followed, alignment of the trunnions on opposite sides of the expansion link will not be possible and a poor running engine will result.

PROCEDURE (applicable to either plates or brackets)

1. Layout, drill and ream trunnion brackets (or trunnion plates.)
2. Machine trunnion brackets to form, to be snug fit on links.
3. Make soft steel or brass shaft to be snug fit in reamed hole.
4. Make bushing to be snug fit on shaft and snug fit in link slot.
5. Assemble trunnion bracket (or trunnion plates) on link using shaft and bushing for alignment. Locate pin at its proper position in the link, clamp assembly together to prevent movement during drilling operation.
6. Drill through with tap drill (see drawing).
7. Disassemble, then drill link and one of the two brackets to body drill size, tap other side 4–40 (1" scale). Repeat on other bracket body.
8. Silver solder, chrome moly (4140) preferred, trunnions in the brackets.
9. For the trunnion bracket, saw off the bridge connecting the two sides, then dress up the saw marks on the brackets.
10. Assemble with socket head cap screws, heads to the outside. This means that bracket halves must be made rights and lefts. Trunnion plates may be drilled through with body drill using nuts on the inboard side. Where links are mounted in solid frames, don't consider silver soldering the brackets to the links since, if it is done, assembly into the frame or link support bracket will be impossible.


reverse shaft bearing-silver solder to cross member, ¼" dia shaft for 1" scale
10-32 socket head cap screw (for 1" scale)
cross member (frame spreader)
frame
brake hanger bracket
oil hole
link support bracket (cast iron)
drill and ream ¼" dia (for 1" scale) before cutting away center

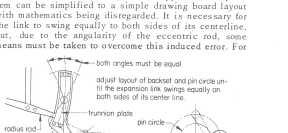
LINK HANGER BRACKET MOUNTING


frame
Gits oil hole cover
note: this crosshead guide support and frame spreader simulates that used on K-4s no. 5495-5499.
crosshead guide
crosshead guide support and frame spreader plug

CROSSHEAD GUIDE MOUNTING

BACKSET

This design function has many novice engine builders worried; but by taking the practical approach, the problem can be simplified to a simple drawing board layout with mathematics being disregarded. It is necessary for the link to swing equally to both sides of its centerline, but, due to the angularity of the eccentric rod, some means must be taken to overcome this induced error. For


both angles must be equal
adjust layout of backset and pin circle until the expansion link swings equally on both sides of its center line.
trunnion plate
pin circle
radius rod
backset
note "all square" layout
eccentric rod
return crank

LAYOUT PROCEDURE

this reason, the eccentric rod pin is located to the back of the expansion link trunnion perpendicular center line. The simplest way is to use the trial and error method of laying it out on the drawing board with dividers. Where layout is done to a larger scale than the proposed locomotive (2X, 3X, etc.) accuracy is improved in proportion to the scale used. Where the complete valve gear is in perfect proportion as a prototype, including the throw of the eccentric crank, a drawing of the prototype expansion link may be used. Within certain limitations, this method will provide a satisfactory backset.

RETURN CRANK

A return crank is an outside valve gear equivalent of an eccentric. For an "all square" valve gear, the return crank pin is 90° ahead of the main crank pin for outside steam and 90° behind the main crank pin for inside steam. While most Walschaerts valve motions are "all square", some are slightly inclined. The Baker valve motion is always inclined for mechanical reasons; however, the valve gear may be made "all square" for a Live Steam free lance locomotive. Whether the valve gear is inclined or "all square" determines the length of the return crank and also its relation to the center line of eccentric rod movement.

Since the return crank drives the expansion link at the link foot some distance below the link block in full forward gear, it is to be expected that the throw of the eccentric crank will be considerably greater than the maximum valve travel. It must be realized also that the action of the lap and lead lever is not added to that of the expansion link, but goes along with it as a conjugate action. The dimensions of the return crank pin circle in relation to the travel of the link block is found as follows:

$$PC = \frac{T \times D}{d}$$

Where: PC = Pitch Circle, return crank (throw)

T = Travel of link block.

D = Distance from link trunnion to eccentric rod pin

d = Distance from link trunnion to link block (full gear).

CAUTION: Return crank pins must be set at their designed throw. Do not attempt to increase or decrease their throw by revolving them on the main crank pins

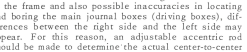
"ALL SQUARE" LAYOUT
TYPICAL FOR WALSCHAERTS

INCLINED LAYOUT
TYPICAL FOR BAKER

since this will incline their action and will seriously effect the timing of the valve events. If the return crank is not right, weld up the crank pin hole, or plug it (silver solder the plug) and try again, otherwise, make new ones and scrap the defective one(s).

ECCENTRIC ROD

Due to differences between the right and left sides of the frame and also possible inaccuracies in locating and boring the main journal boxes (driving boxes), differences between the right side and the left side may appear. For this reason, an adjustable eccentric rod should be made to determine the actual center-to-center distances of the permanent rods. Since this rod will be used only once on each side, it may be made from any available 1/8" or thicker flat stock: aluminum, brass or mild steel. By starting out the adjustable rod at its



TRIAL ECCENTRIC ROD
WALSCHAERTS OR BAKER

proposed dimension, if the operation is not correct, adjust the rod for length by setting that side on dead center, then swinging the radius rod from full forward to full reverse. Adjust length of adjustable eccentric rod until the radius rod can be moved from one end of the link to the other without moving the valve stem. After the length of the rod on that side has been determined, transfer the center-to-center dimensions to the permanent rod, then drill and ream to size. Repeat operation on other side.

As a word of warning, three things that will make a lame engine in a hurry when the lap and lead lever is correctly drilled and the lead is properly set are:

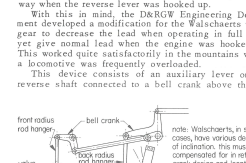
1. The return crank not properly set to its designed throw (an attempt to get more or less valve travel than the return crank was designed for).
2. An eccentric rod too long or too short.
3. Radius rod lifting link not swinging true with the swing of the expansion link, but swinging so that the link block travels up hill and down hill, will cause uneven valve travel. That is: even though the valve is perfectly centered with relation to the motion of the lap and lead lever in full gear, it will travel farther on one side of center than the other side. Trial and error drawing board layout is necessary to properly locate the reversing shaft. If the reverse shaft is not properly located and/or the lifting links (radius rod hangers) are not the proper length to get the proper swing, an engine can run fairly well in forward, yet be very lame in reverse, or vice versa. Where the same valve motion is desired in forward and reverse either on free lance or following certain prototypes, the radius rod guide will give a uniform motion with the link block in either the upper half or the lower half of the expansion link, and is recommended. The Young valve motion is a good example of the utility of this radius rod control, since on this motion, the link block on one side of the engine is in the upper half of the expansion link while the link block on the other side of the engine is in the lower half of the expansion link.

VARIABLE LEAD WALSCHAERTS VALVE MOTION

The Denver & Rio Grande Western is a railroad through the Rocky Mountains and much of their operation consists of starting on heavy grades. Tractive rates of variable lead pointed out that the Stephenson valve motion with its variable lead made an easier starting engine than one with a radial valve gear, since with the Stephenson, the lead disappeared when the engine was put in full gear and returned after the train got under way when the reverse lever was hooked up.

With this in mind, the D&RGW Engineering Department developed a modification for the Walschaerts valve gear to decrease the lead when operating in full gear, yet give normal lead when the engine was hooked up. This worked quite satisfactorily in the mountains where a locomotive was frequently overloaded.

This device consists of an auxiliary lever on the reverse shaft connected to a bell crank above the lap

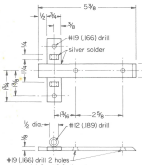

front radius rod hanger
bell crank
note: Walschaerts, in some cases, have various degrees of inclination, this must be compensated for in return crank design and location of return crank pin.
block radius rod hanger
valve stem
radius rod
valve stem crosshead
lap and lead lever
eccentric rod
union link
crosshead
main rod
return crank

VARIABLE LEAD WALSCHAERTS

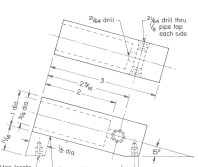
and lead lever. The bell crank supports the radius rod end in a sliding block located in the upper end of the lap and lead lever. When hooked up, the block is at the top of the slot which gives lap and full lead. When the engine is in full gear, the swing of the reverse shaft moves the end of the radius rod closer to the valve stem. This gives full lap but eliminates the lead for starting and for heavy pulling at slow speed. The D&RGW found this modification very satisfactory; however, the other Rocky Mountain railroads failed to adopt it. Probably with the idea that the advantage of easier starting was not worth the cost of the extra maintenance. This was the case with many valve motions that gave practically perfect steam distribution.

tender hand pump

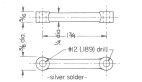
WHM/wf @ WHM 1982



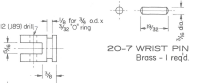
20-3 BASE PLATE
Brass - 1 required



20-4 PUMP CYLINDER
Brass - 1 required



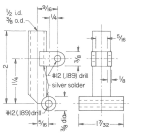
20-6 CONNECTING ROD
Brass - 1 required



20-5 PUMP PISTON
Brass - 1 required

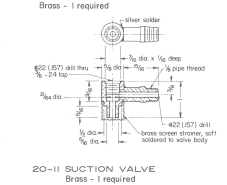
20-9 PIN
Brass - 1 req'd.

20-7 WRIST PIN
Brass - 1 req'd.

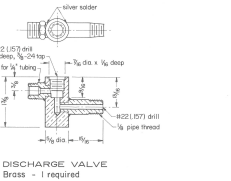


20-8 PUMP LEVER
Brass - 1 required

20-10 BEARING PIN
Brass - 1 required



20-11 SUCTION VALVE
Brass - 1 required



20-12 DISCHARGE VALVE
Brass - 1 required

building the RARITAN

by William H. Morewood

The Tender Hand Pump (20–3 to 20–12) should be made next as it will be needed to pressure test the boiler. Silver solder the support post to the cylinder and then drill and tap for the water connections and for the 8–32 base screws. Drill and bore the cylinder and then screw and solder it to its base.

The plunger should be a close sliding fit in the cylinder. The pump will work without an "O" ring but there will be leakage. An "O" ring should be so fitted that it will just interfere with the cylinder wall.

Leave the strainer off the suction valve for the time being. A hose may then be slipped onto this valve to supply water for testing. The strainer may be made from the brass screen used over laboratory Bunsen burners and should be added before the pump is installed in the tender tank.

HEAT TREATMENT for the apprentice

by Jack D. McKenty, M.D.

Part 2

Annealing Carbon Steel

Carbon Steel is usually obtained in softened form, but don't trust it. Trying to cut off a length of hardened drill rod can take all the teeth off your hacksaw blade in two strokes. Test it first. If you can file a small notch at the place you want to cut, it is soft. If the file skids across the surface, it is hard, and must be softened before doing anything else.

Lengths of carbon steel are usually annealed most easily in the open air. To keep both hands free for the work, lightly clamp the propane torch in your vise, with the burner pointing away from you. The small tank can be stood on end, but it is too tippy to be safe.

The steel is then held in the flame until it is the proper heat. I can't remember who to credit, but some clever person described it as "the color of cooked carrots." A longer length than can be heated at one time is passed slowly through the flame, advancing as each section reaches annealing temperature.

Carbon steel, unlike copper, must be cooled slowly or it will harden again. Small pieces can be left to cool in the air, resting on a firebrick. Larger chunks should be placed in the vermiculite, or in ashes or dry sand to cool. After it is cool, clean off the scale with emery paper.

The softened steel can then be worked on. To harden the finished work piece, heat it up to the same "cooked carrot" color and immediately plunge it vertically into a bucket of water. Don't take it out until everything, including the pliers you are holding it with, is at water temperature. Clean it with emery paper again.

The work piece is now "glass hard". It is hard enough to scratch glass, and if you hit it with a hammer it may shatter. Some of the brittleness must be taken away by tempering.

Generally speaking, toughness and hardness are at opposite ends of the scale. The harder the metal is, the more brittle. The tougher and more malleable it is, the softer. A compromise must be reached which depends on the projected use of the finished work. In the right hand column of Table I are listed a number of things that carbon steel is used for, including some that are not too common in the home workshop. Let us suppose you are making a little end-mill. As the work piece is heated, there is a series of color changes on it. These are surface changes only, but they reflect the temperature of the metal at that place. (See left hand column, Table I.) The work should be bright and shiny (emery paper) to start with. The heat is applied gently to a place away from the cutting end of the piece, and as soon as the desired temperature is reached, the work is plunged vertically into cold water.

If the process is interrupted and the work cools, or if the work is over-heated, it is best to reharden it and start over.

You will learn more about this process by trying it once than by reading a whole library about it.

Springs

The reason that home made springs are seldom the equal of manufactured ones is that it is difficult to temper them properly at home. Table I says bright blue. This is true, but bright blue all over, at one time. Heating one end doesn't achieve this.

You can come close if you use a muffle furnace or kiln, but you have to move quickly to get the springs out of the furnace into the quenching water. A sand bath can be used. This is a shallow metal tray of sand heated by a bunsen burner or the propane torch. The springs are put in a few at a time and stirred around until tempered; then quenched.

Case Hardening

Mild steel is low carbon steel and no combination of heating, cooling, quenching, hammering, bending or anything else is going to harden it. In case hardening, the surface layer of steel is turned into carbon steel by the addition of extra carbon. This surface layer can then be

hardened. The process is applied to gears and other parts subject to wear, such as the valve motion on a small locomotive. It has the advantage that the bulk of the metal away from the hard surface is still tough rather than brittle.

A commercial source of external carbon is "Kasenit", available from Cole's Power Models. The piece to be case hardened is heated to glowing, then dipped in the Kasenit which is in powdered form. Some powder adheres, and the heating is continued. The process is repeated when the powder burns away or drops off. After about 15 or 20 minutes of this, the work is quenched and the excess powder is cracked off. This process is uneven, uncertain, and slow, but it can be done.

There is a better way. The parts to be hardened are sealed in a ceramic box along with the Kasenit, or a mixture of ground bone and scraps of leather. The box is placed in a furnace (muffle, kiln or the one in your basement) and left at red heat for 15–30 minutes. The box is then opened while still hot and the parts tipped into water.

The kiln is best for this job. The same ceramic supply store which sells the kilns also sells clay for making the boxes and slip (or liquid clay) for sealing them. Some experimenting is necessary to find the right time-temperature combination for the degree of case hardening desired.

One Other Process

Mild steel cannot be hardened, but stock sections often need to be annealed. The stresses locked up in the metal by the rolling it gets in the steel mill often causes it to bend or curve when pieces are cut from it.

Commercially this is done by sealing the steel in a cast iron box through which hydrogen is passed, heating the whole box red hot in a furnace for a while and letting it cool slowly. The hydrogen prevents oxidation; the piece comes out a beautiful blue color.

This cannot be done very well at home. Going over the uncut section with a propane torch and heating it up a little spot at a time can be helpful, but can only be done for smaller pieces. If you have one of those self-cleaning ovens that goes to 700°F and burns off the grease, it seems to me that it might be of help. Leaving the piece of steel in the oven while it is being cleaned about three times might be a substitute for "weathering" which is another way of annealing it but takes about three years. Maybe somebody could try this and report on it.

Next month's subject will be *FILES for the apprentice.*

Table I

Temperatures of Tempering Colors

Tint of Oxide on Surface of Steel	Centigrade Degrees	Farenheit Degrees	Suitable for
Pale yellow	221	430	Small edge-tools, small lathe-, planing, and slotting tools. Scrapers
Straw	230	446	Razor blades.
Golden yellow	243	470	Penknives, hammers, taps, reamers, planing- and slotting-tools, small drills, screwing-, stamping-, and cutting-dies, miners drills, milling cutters, D-bits.
Brown	254	490	Scissors, shears, cold chisels, large drills, shear blades, punches and wood cutting tools.
Brown, beginning to show purple	266	510	Axes, planes and wood-working tools
Purple	277	530	Table knives, large shears, wood-turning tools.
Bright blue	288	550	Watch springs, swords.
Blue	293	560	Fine saw blades, augers, boilermakers' snaps, chisels, smiths' tools, cold setts.
Dark blue	316	600	Hand saws.

From Newnes Engineer's Manual, slightly modified.

BOUND VOLUMES OF LIVE STEAM AVAILABLE

In the confusion of moving up here to Wildwood Farm plus an immediate plunge into complete remodeling of the home, we were not too surprised (completely disgusted, perhaps, but not surprised!) to discover all of a sudden that the January 1967 issues of LIVE STEAM that had been held for binding had all been used to fill orders for back issues from subscribers!

After a couple of months of searching during spare minutes, all of the negatives for the original plates were located and the stripped-in ads pulled from subsequent issues in order that new plates could be made. A new run was made to provide the complete set and now we can again advise that they are available.

Volume One includes all issues of 1967 plus the five issues published during the latter part of 1966. Even the August 1966 pilot edition is bound into the Volume One.

Volume Two includes all 1968 issues and is indexed extensively, as is the first volume.

They are bound in hard covers in dark green with gold stamped title and LIVE STEAM logo. Order your copies now at $12.00 each from LIVE STEAM, Box 635, Cadillac, Michigan

BLS DIRECTORY NOW READY

Although it may have been some time since you filled out the card for your listing in the BLS Directory, you may recall that one of the questions asked was, "Would you buy a $2 Directory of all BLS Members?"

On the basis of the affirmative indications on the returned cards, Harry Dixon, Ed Kruckeberg, Halsted Park, Jr., and the LIVE STEAM staff have put countless hours of effort into this project and it is now in the hands of many of the Live Steamers around the country.

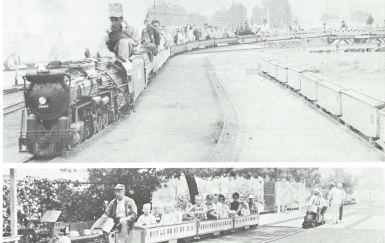
If you checked that card "Yes", your copy is ready now . . . and if you haven't sent in your $2.25 for your copy, please do so at once.

If you are a new-comer to this hobby, you would have special use for this BLS Directory. It can help you get acquainted with other Live Steamers in your area, help you plan ahead on a trip to meet others with like interests, show you how to locate several of the Live Steam Club tracks and the person to contact in any of the 55 Live Steam Clubs in the United States and Canada.

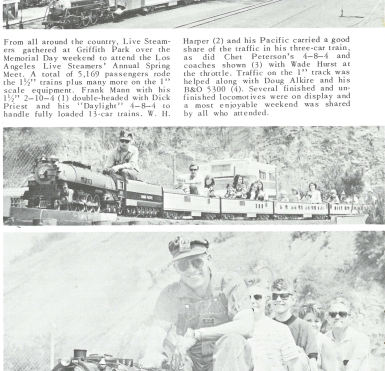
Order your copy now. Send $2.25 to LIVE STEAM, Post Office Box 635, Cadillac, Michigan 49601 to get your copy by return mail.

LALS SPRING MEET

PHOTOS BY BRUCE WARD
PROCESSING BY DOUG ALKIRE



From all around the country, Live Steamers gathered at Griffith Park over the Memorial Day weekend to attend the Los Angeles Live Steamers' Annual Spring Meet. A total of 5,169 passengers rode the 1½" trains plus many more on the 1" scale equipment. Frank Mann with his 1½" 2–10–4 (1) double-headed with Dick Priest and his "Daylight" 4–8–4 to handle fully loaded 13-car trains. W. H. Harper (2) and his Pacific carried a good share of the traffic in his three-car train, as did Chet Peterson's 4–8–4 and coaches shown (3) with Wade Hurst at the throttle. Traffic on the 1" track was helped along with Doug Alkire and his B&O 5300 (4). Several finished and unfinished locomotives were on display and a most enjoyable weekend was shared by all who attended.



NEW CLUB OFFICERS . . .

in Montreal

W. B. Scott was re-elected President of the Montreal Live Steamers, Dave Mullings as Vice President and Stanley H. Galloway re-elected to the office of Secretary-Treasurer. An increase in dues necessitated by the purchase of land for a club site at Cedars brought no complaints from the membership. It looks as though the membership list will equal last year's regular members but the number of associates exceeds the 1968 list. For further information, contact S. H. Galloway, 53 Brentwood Road, Beaurepaire, Quebec.

in New Jersey

On April 20th, the New Jersey Live Steamers elected Joel Beecher as their new President, David Wojtowicz as Vice President-Treasurer for a second term, and Ralph Green to continue as Secretary. Past President Larry Green and Stanley Robinson were voted into two-year terms as Directors. For additional details on joining this active group or attending their meets, contact Ralph W. Green at 845 Kilsyth Road in Elizabeth, New Jersey 07208 or phone 201 – 353-4424.

in Los Angeles

Officers for 1969 are Chet Peterson as President, Doug Alkire as Vice President, Joel Corbin as Secretary and Don Pergande as Treasurer of the Los Angeles Live Steamers. This active group is busily engaged in reworking their track and facilities in preparation for the National Meet of the Brotherhood of Live Steamers next May. If you are interested in joining this club, contact Joel Corbin, 12723 Kittridge Street, North Hollywood, California 91606. If you have questions about the National Meet, write to Joel at the above address but mark your envelope "BROTHERHOOD MEET" and be sure to enclose a stamped, address-ed envelope for his reply.

in Chicagoland

The Northern Illinois Live Steamers, busy with trackwork and all the details incidental to preparing a new Live Steam club facility, took time out on June 15th to elect a slate of officers suggested by the nominating committee. Matt Fatche remains as President, Nick Schaub will be 1st Vice President, Al Schneider is 2nd Vice President, Bud Novy is Secretary and Russ Decho is Treasurer. Don McCormac and Oakley Little are new Board members. All Live Steamers are anxiously awaiting completion of the new NILS track, but if you want to get in on the activity, contact Bud Novy, Secretary, 1445 Ash Avenue, Westchester, Illinois 60153.

in Oakland

The Golden Gate Live Steamers also have a new slate of officers which include John Curtis in the President's chair, Earl Chanda as Vice President, Gordon French as Secretary and Curtis Janssen as Treasurer. There is always plenty of activity on Run Days at the track and if you want to be a part of this group of avid Live Steamers, get in touch with Secretary, Gordon French, 614 18th Avenue, Menlo Park, California 94025.

August

30 PENNSYLVANIA LIVE STEAMERS
31 STEAMERS
1 Annual Fall Meet
2½" – 3½" – 4¾"
Wm. H. Scott, Secretary
R.D. 1, Box 400
Sellersville, Pa., 18960

31 FIRST TEXAS MEET
1 7½" gauge
L. L. Yates' track
Box 631
Falfurrias, Texas 78355

September

6 IOWA MODEL STEAM
7 ENGINEERS
Annual Fall Meet
Pershing G. Scott, Secretary
R.F.D. 1
Marion, Iowa 52302

13 NORTHEAST OHIO AREA
Organizational Meet
Clinton Ensworth's track
Contact either
Clinton B. F. Ensworth
Route 1
6829 Bear Swamp Road
Medina, Ohio 44256 or
Richard H. Date
369 Franklin Avenue
Barberton, Ohio 44203

13 GOLDEN GATE LIVE STEAMERS
Annual Fall Meet
2½" – 3½" – 4¾" – 7½"
Gordon French, Secretary
614 18th Avenue
Menlo Park, Calif. 94025
Phone 415 – 325-4209

19 NEW JERSEY LIVE
20 STEAMERS
21 ADVANCE REGISTRATION REQUIRED
3½" – 4¾" – 7½"
Ralph Green, Secretary
845 Kilsyth Road
Elizabeth, N. J. 07208
Phone 201 – 353-4424

20 MICHIGAN STEAM LOCOMOTIVE CLUB
C & L C – Cadillac
J. Bullock, Secretary
94 Boxwood Drive
Davison, Michigan 48423

October

4 LOS ANGELES LIVE
5 STEAMERS
Annual Fall Meet
3½" – 4¾" – 7½"
Joel Corbin, Secretary
12723 Kittridge Street
North Hollywood, Calif. 91606

11 PIONEER VALLEY LIVE
12 STEAMERS
3½" – 4¾" – 7¼"
Brenton W. Barnfather, Secy.
3 Fleetwood Drive
Sandy Hook, Conn. 06482

11 SOUTHERN MINNESOTA
12 LIVE STEAMERS
3½" – 4¾" gauge
Al O'Neil's track – Lake City
Richard M. Winkle, President
220 First Ave., S.W.
Rochester, Minn. 55901

Regular Run Days

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Every Sunday, weather permitting
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Gordon French, Secretary
614 18th Avenue
Menlo Park, Calif. 94025
Phone 415 – 325-4209

JAMUL VALLEY RAILROAD
3rd Sunday each month
7½" gauge
Harry F. Haas
Route 1, Box 47 A
Jamul, California 92035

NEW JERSEY LIVE STEAMERS
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2½" – 4¾" – 7½"
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Elizabeth, N. J. 07208
Phone 201 – 353-4424

PIONEER VALLEY LIVE STEAMERS
2nd Sunday each month
3½" – 4¾" – 7½"
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3 Fleetwood Drive
Sandy Hook, Conn. 06482

PENNSYLVANIA LIVE STEAMERS
May 11, June 15, July 13,
Aug. 10, Sept. 14, Oct. 12
Wm. H. Scott, Secretary
R.D. 1, Box 400
Sellersville, Pa., 18960

LOS ANGELES LIVE STEAMERS
1st Sunday each month
3½" – 4¾" – 7½"
Joel Corbin, Secretary
12723 Kittridge Street
North Hollywood, Calif. 91606

MONTREAL LIVE STEAMERS
1st Sunday of each month
3½" – 4¾" – 7¼" gauges
S. H. Galloway, Secretary
53 Brentwood Road
Beaurepaire, Quebec, Canada

RED RIVER VALLEY RAILWAY
Every Sunday, weather permitting
June 1st through Sept. 20th
2½" – 3½" – 7½" gauge
Paul Winslow, Secretary
304 – 1179 Grant Ave.
Winnipeg 9, Manitoba, Canada

RIVERSIDE LIVE STEAMERS
4th Saturday-Sunday each month
Hunter Park – Iowa & Columbia Ave.
Riverside, California
Francis H. Smith, Secretary
5536 Dewey Street
Riverside, California 92504
Phone 688-9533 or 683-9628

SOUTHERN CALIFORNIA LIVE STEAM CLUB
3rd Sunday each month
3½" – 4¾" – 7½"
K. G. Kepner, Secretary
2764 Maple
Rialto, California 92376

WABASH, FRISCO & PACIFIC
Every Sunday
12" gauge
Grand and First Streets
0.4 miles south of Post Office
Glencoe, Missouri

WAUSHAKUM LIVE STEAMERS
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Ashland, Mass.,
Wendell C. Bishop, Secretary
52 Pond Street
Natick, Mass. 01760

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THOUGHTS ON TUBE SIZE

Many years ago we had an interesting talk given to us by some representatives from Reunert & Lenz, agents for the North British Locomotive Company on boilers. The question of the blocking of tubes with soot and carbon was raised, and they could not understand why this should happen. There was something wrong somewhere.

I thought about this for quite a while as the problem was giving us a lot of trouble. It was usual to make up a ramrod with a glass hard steel disc on the end to clean the tubes, and often this ramrod had to be hammered through to clear the deposit. It was through doing this that a combustion chamber strut got a hole knocked in it. Another engine actually had a tube cut through by one of these rods and the owner had to block off that particular tube. It was some time before I came up with the answer, and when I found it, it knocked a pretty big hole in all the usual theories regarding tube diameters in our small locos. We were using tubes which were too large in diameter! Here's why. . . .

The gases are sucked through the tubes by the vacuum created in the smokebox by the exhaust from the cylinders. Now it is obvious that this vacuum causes the gases to flow through the tubes at a velocity which depends on the diameter of the tubes, and the larger the tube, the lower the velocity. Conversely, the smaller the tube, the higher the velocity. Now, the gases do not flow through at a uniform rate. They are at their highest velocity at the center or core of the tube and become progressively slower as they approach the tube wall until right next to the wall they are practically stationary. This is known as the "boundry layer." Here is where the velocity comes in. The lower the velocity, the thicker is this layer, and it is within this layer that the soot particles get trapped and deposited on the tube wall. The thicker the layer, the thicker the initial deposit of soot, and it builds up rapidly because the velocity is not sufficiently high to prevent the rough surface of the deposit from catching and holding successive particles, and the tube can become completely blocked.

If small diameter tubes are used, the velocity, being higher, reduces the boundary layer to a minimum and only a small deposit of soot results – the rest being drawn through the tubes and discharged out the chimney. By the same token, more heat can be transmitted through the walls of the tubes, since flue gases are notoriously bad conductors of heat, and the thinner the boundary layer, the more heat can get through. You also score in that by using smaller tubes you can get more in and so increase the heating surface.

Now somebody is going to say, "OK, wise guy, what diameter tubes should we use?" This depends on a number of factors, but assuming that the smokebox is air-tight and the front end properly designed, when we have to find a tube diameter which is practically immune from blockage, maintains a high velocity, and does not exceed practical limits. In full size practice, the ratio of length to diameter is between 80 and 90 for main line locomotives, but for a 3/8" tube this would give us a length of about 32" which is not practical. In "Green Goddess"! I used a ratio of 40 and it seems to be about right. I don't get any heavy deposit on the tubes and I can clean them with one pass of a soft brass wire brush such as is used for cleaning the barrel of a .303 rifle.

From what I have experienced and seen, I would suggest that the following diameters would be pretty close to the mark: Tubes 5" to 10" long – ¼"; over 10" to 15" – 3/8"; over 15" to 20" – 7/16". For 1½" or 3" scale I would suggest a ratio of 70, and above that work to full size ratios. Please note that I am referring to the bores of the tubes and not the outside diameters.

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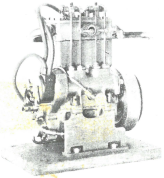

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